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狗鱼(*Esox*, Teleostei)化石在中国的首次发现[1)]

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摘要 记述了山东龙口黄县洼里煤矿早始新世黄县组二段油页岩中的鱼化石。该鱼身体狭长,背鳍位置靠后;额骨侧面有长形的、狗鱼所特有的副筛骨;额骨甚长;顶骨相对来说甚短;口裂较长;齿骨、前上颌骨及颚部许多骨片均生有扁而尖的牙齿,但上颌骨口缘光滑;外翼骨甚粗壮;鳃盖骨略呈长方形;前鳃盖骨较直,中部略收缩,上、下枝夹角大(约为130°);匙骨纵枝短而水平枝长大。因此属于狗鱼科中惟一的狗鱼属是毫无疑问的。根据其头长与体长之比、额骨及顶骨的形状和比例以及背鳍条数目与狗鱼属其他种的不同,我们将它订为一个新种——龙口狗鱼。黄县的化石是狗鱼渐新世以前在北美以外地区的首次发现,也是狗鱼化石在亚洲的首次发现。黄县位于北纬37°7′,远较现生狗鱼在亚洲分布的地区(43°和46°以北)靠南。而始新世全球气候偏暖,且南北温差较小,始新世狗鱼或较现生种类更适应较温暖的气候。早始新世狗鱼在中国的发现为当时跨太平洋鱼类区系的存在提供了进一步的证据。

关键词 山东龙口,始新世,狗鱼,中国的首次发现
中图法分类号 Q915.862

1 引言

狗鱼科(Esocidae)是现代北半球北部的一种冷水性淡水鱼类,仅包括狗鱼(*Esox*)一属。现生狗鱼共有5种,其中赖氏狗鱼(*E. reicharti* Dybowski)分布于我国东北部黑龙江、松花江、乌苏里江流域及邻近地区;西伯利亚东南部,它们的分布大多在北纬43°以北;白斑狗鱼(*E. lucius* Linnaeus)分布在连续的北极圈周边地区,在亚洲的分布比赖氏狗鱼略偏北,在我国产于新疆额尔齐斯河流域,约在北纬46°以北(孟庆闻等,1995;Berg, 1948),在欧洲及美洲的分布偏南;其他3个种(*E. masquinongy*, *E. niger* 及 *E. americanus*)都分布在北美洲东南部,比前面两个种的分布地区显著靠南,最南的(美国佛罗里达州)接近北回归线(Grande, 1999,图10)。

早期化石狗鱼的分布和现代狗鱼很不相同。最早的狗鱼化石发现于加拿大阿尔伯塔省和美国怀俄明州晚白垩世地层中(Wilson et al., 1992)。古新世(Wilson, 1980, 1984)、始新世的狗鱼(Wilson, 1981; Grande, 1999)此前亦仅发现于北美。到了渐新世,它们才在西欧(Gaudant, 1978, 1987)、西西伯利亚和中亚(Sychevskaya, 1974, 1976)出现。中新世以后,

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它们的分布更其广泛,中新世、上新世在欧(Sychevskaya, 1976; Gaudant, 1987, 1997)、美(Cavender et al., 1970)、西伯利亚和蒙古(Sychevskaya, 1976),更新世在欧、美及亚洲北部的许多地区都发现了狗鱼的化石(Grande, 1999,图 10)。但狗鱼化石在中国尚属首次发现。

虽说在发现了太平洋两岸始新世鱼类区系的惊人相似之后(张弥曼、周家健,1978;张弥曼等,1985;Chang and Zhou, 1993),而且在世界其他地区自渐新世以来的地层中都发现了狗鱼化石的情况下,本文记述的始新世早期或甚至古新世的狗鱼化石在中国的发现,原是意料之中的事,但它却姗姗来迟。这可能有两个原因,一是化石的数量较少,发现的几率较低;二是过去曾发现的一些化石零散骨片被误认为是鼠鱚科鱼类(gonorhynchids,张弥曼、陈宜瑜,2000)。近来本文作者在重新观察这些标本时才发现,它们是狗鱼而不是鼠鱚。

1990、1994 年本文第二作者到山东龙口黄县洼里煤矿(图 1)进行采集时,在黄县组二段(含煤层)的油页岩中采到了不少零散的鱼类骨片、保存不甚完整的头部及一个保存很差的鱼体。其中一部分零散骨片属于弓鳍鱼科(Amiidae),笔者将另行记载。另一部分则属于本文将要讨论的狗鱼。



图 1 龙口狗鱼化石地点

Fig.1 Map showing the locality of *Esox longkouensis* sp. nov.

黄县组是一套含煤岩系,自下而上分为三段,一段由粘土岩、泥岩、泥灰岩、生物碎屑灰岩及沙砾岩组成;二段为含煤段,由煤层、油页岩、含油泥岩、炭质泥岩、泥质灰岩、白云质灰岩等组成;三段由泥岩、泥质灰岩、钙质泥岩等组成。黄县组主要分布在胶东半岛黄县和龙口等地,地表未见出露,均见于钻井或矿井中。黄县组中至今未发现哺乳动物化石,但含大量孢粉和介形类,其下部(曾被称为龙口组)含 *Paraalnipollenites-Betulaepollenites plicoides-Polypodiaceaesporites* 孢粉组合,与昌乐—潍坊凹陷侯镇组的孢粉组合一致,属古新统。其中、上部含 *Alnipollenites-Tiliaepollenites-Taxodiaceaepollenites hiahus* 孢粉组合以及介形类 *Eucypris wutuensis*,可与济阳凹陷的孔店组至沙河街组下部地层中的组合对比;亦与昌乐五图附近五图组中的同类生物比较相近(李经荣等,1992)。五图组的时代根据其上部所产的脊椎动物原始貘形类五图始祖貘(*Homogalax wutuensis*)和附近临朐牛山与五图层位相近的始新统地层中的牛山犀貘(*Heptodon niushanensis*)等分别定为早始新世早期及中、

晚期(周明镇、李传夔,1965),黄县组的时代即参照五图组的时代定为早始新世(山东省地质矿产局,1991;李经荣等,1992;郑家坚等,1999)。近来五图组中新发现了大量哺乳动物,研究这些化石的部分学者仍认为五图组的时代为早始新世(童永生、王景文,1996,1997,Tong and Wang, 1998),但另一些学者,基于化石的系统发育、动物地理、古气候的变化以及生物地层学方面的研究结果,建议五图组也有属于古新统上部的可能(Beard and Wang, 1995; Tong and Dawson, 1995; Beard, 1998; Beard and Dawson, 1999)。

化石标本均用机械方法修理。同时,我们还观察了古脊椎动物与古人类研究所标本馆收藏的现生赖氏狗鱼骨骼(古脊椎动物与古人类研究所标本号 P.37),并从黑龙江省建三江购得三尾赖氏狗鱼,剥制成零散的骨片,以与化石作比较。Agassiz(1833 ~ 1845)的图鉴也用作主要的参考。但骨片名称则根据 Wilson(1984)及 Grande(1999)。

2 标本描述

真骨鱼类 Teleostei
狗鱼目 Esociformes
狗鱼亚目 Esocoidei Berg, 1936
狗鱼科 Esocidae Cuvier, 1817
狗鱼属 *Esox* Linnaeus, 1758
龙口狗鱼(新种) *Esox longkouensis* sp. nov.
(图2 ~ 7)

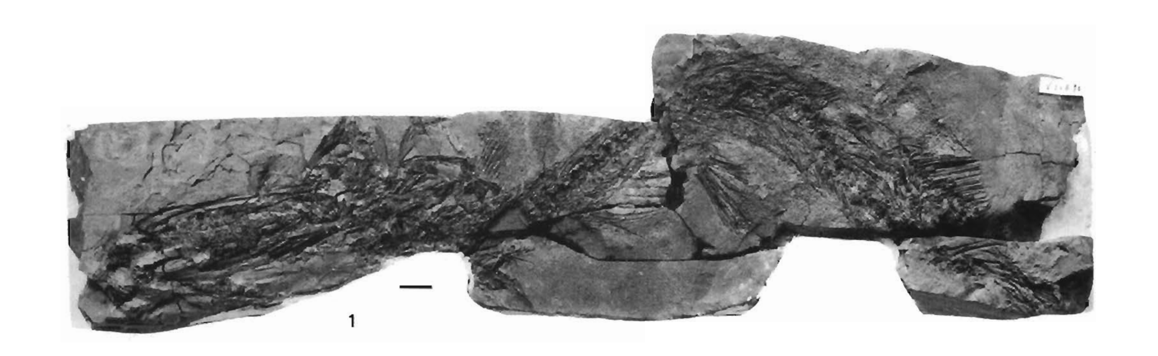
种征 具有以下特征组合的一种狗鱼:头长为体长之0.33,与北美怀俄明州早始新世晚期的 *E. kronneri* 的这一比值(0.34)接近并与 *E. lucius* 及 *E. reicherti* 中有重叠的情况;额骨宽长比为0.29,为 *E. kronneri* 额骨宽长比(0.19)的1.5倍;顶骨宽与长之比为1.53,较 *E. knonneri* 的同一比值(1.88)要小;鳃盖骨的形状更加接近 *E. kronneri* 和狗鱼现生种类中的情况,与 *E. tiemani* 中的情况差别较大;背鳍条 V + 18 = 23 根,与 *Esox* 亚属中的三个种接近,较其他现生及化石种中为多(见 Grande,1999,表2;*E. kronneri* 中为 V + 14);前鳃盖骨较直,但其上、下枝夹角(130°)与 *E. tiemani* 中(约130°,据 Wilson,1984,图2)相近而小于 *E. kronneri*(约140°,据 Grande,1999,图2B)。狗鱼属中的一些化石和现生种的特征在龙口狗鱼中呈镶嵌分布。

正型标本 一保存了较多骨片的头骨,示腭面、颅顶腹面、颌部及头部其他骨片,古脊椎动物与古人类研究所标本号 V 11690.2。

副型标本 惟一保存了鱼体的标本,但鱼体剧烈扭曲。头部保存为腹压状态,身体前部仍呈腹压状,后部渐转为左侧压,标本号 V 11690。一保存较好的颅骨顶部,V 11690.1。

其他材料 零散骨片标本9件:V 11690.3 为保存较好的匙骨;V 11690.4 为不完整的额骨;V 11690.5a,b 为相当完整的额骨正、反面;V 11690.6 及 V 11690.7 为角舌骨,前者很完整;V 11690.9,V 11690.10 均为上、下颌部分骨片;V 11690.11 为较完整的舌颌骨、前鳃盖骨上部及后翼骨,V 11690.12 为下颌及上颌骨的大部。

释名 Longkou,化石产地龙口的汉语拼音。



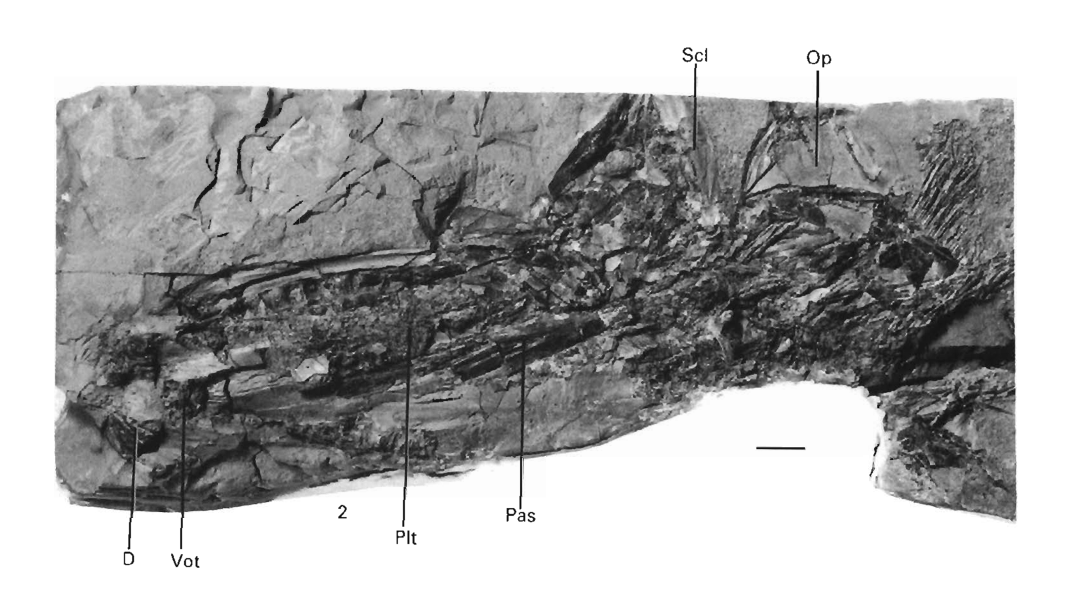


图2 龙口狗鱼,V 11690标本:1. 头部和身体,强烈扭曲;2. 头部腹视,简字说明见图4

Fig.2 *E. longkouensis*, 1. head and body, severely twisted; 2. head in ventral view. For abbreviations see Fig.4

图2~7中标尺均为1cm(Scale bar = 1cm in Figs. 2~7)

产地及层位 山东龙口黄县洼里煤矿,黄县组二段,早始新世(或晚古新世)。

描述 与其他狗鱼中情形相似,鱼体窄长。鱼体的测量数据主要根据副型标本之一V 11690,由于它是一个剧烈扭曲的标本(图2.1),误差难免,但我们仍不得不用它来表明鱼体的大致情况。因尾鳍绝大部分未保存,无法测量全长。体长(standard length)只能分段测量,然后相加,约为471mm,是一个较大的个体,应为成体无疑。头长(因鳃盖骨在标本中略位移,且后部保存不甚完整,头长取自吻端至基枕骨末端再加上约4个脊椎的长度)约156mm,因此头长与体长之比约为0.33,接近北美绿河页岩中的*E. kronneri*中的情况(0.34)。体高亦无法测量,但显然较低。背鳍位于身体后部,臀鳍本身虽未保存,但仍能见它的几个鳍条支持骨,可以推测臀鳍和背鳍的位置大致相对。

头部 在正型标本(V 11690.2)及V 11690.1两个标本上可以看到头部的大多数骨



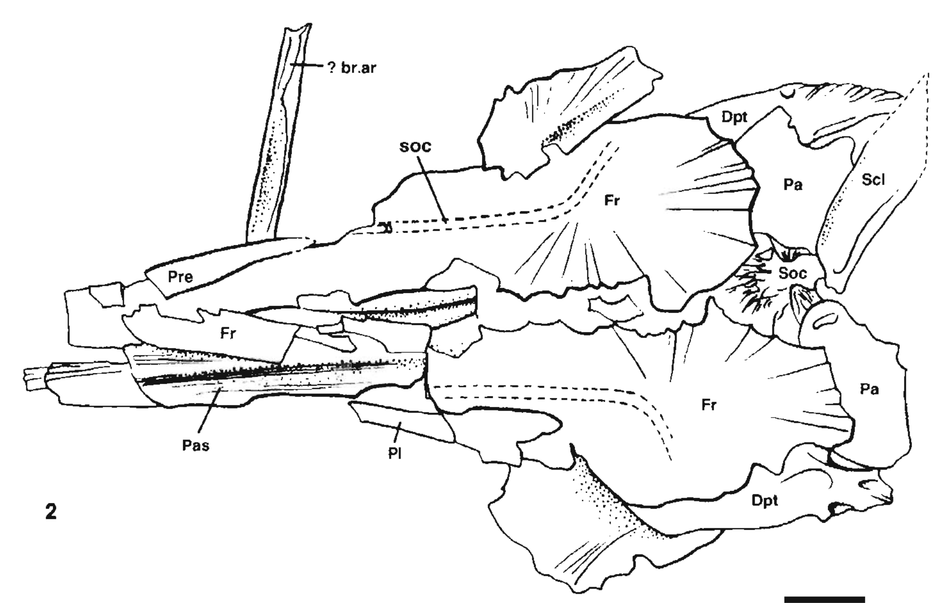


图3 龙口狗鱼,V 11690.1 标本:1,2,头顶部,简字说明见图4

Fig.3 *E. longkouensis*, 1,2, skull roof. For abbreviations see Fig.4

片。V 11690.1 显示了较好的背视颅顶(图 3.1,2),V 11690.4,V 11690.5a,b(正、反面)保存了比较完整的单个的额骨(frontal, 图 5.1),表面平滑,仅自骨片生长中心向前中方及前侧方有少量较弱的放射纹。骨片甚长,长度约为颅顶长度的 5/6(101/121mm,据 V 11690.1,颅顶长度计自额骨前端至翼耳骨后端,因未包括前上颌骨,比颅顶应有的长度略

短)。与另一侧额骨接缝的中缘平直,骨片前部狭窄,向后约至其长度二分之一处向外渐扩展,骨片最宽处约位于其长度的后约 5/7 处,生长中心侧方。其后,骨片又略渐变窄。额骨最大宽度与长度之比为 0.29。骨片后缘较平直。眶上感觉管(supraorbital sensory canal)包于骨片中,由前向后行至生长中心处折向后侧方。与额骨相比,顶骨(parietal)甚短,呈略横宽的长方形。在 V 11690.1 上可以看到基本上在原位并被上枕骨完全分开的左、右顶骨(图 3.2)。宽约 20mm,长 13mm,宽与长之比为 1.53;*E. knonneri* 顶骨的宽与长之比为 1.88(Grande, 1999, p.274)。在正型标本及 V 11690 上观察到略为位移了的顶骨的腹面(图 4.1,2),其上有一纵沟,自前中方斜向后侧方,沟的前端较窄,后端较宽,沟壁甚光滑,估计应曾容纳了耳囊中后半规管的上部。在 V 11690.1 上可以看到上枕骨(supraoccipital)的大部(图 3.1,2),是一个较宽大的骨片,实际上只有骨片中部纵长的狭窄部分在颅顶出露,其余部分被其侧方的额骨和顶骨覆盖。正型标本颅顶后方可能有散落的外枕骨(exoccipital)。额骨后侧缘及顶骨侧缘与翼耳骨(pterotic)相接,后者出露于颅顶的部分为狭长的骨片(dermopterotic),后端尖,突出于颅顶之后,在 V 11690.1 上可见其后侧部表面有几个斜向的脊,使侧缘后部呈波纹状(图 3.1,2)。同一标本额骨前部右侧方保存了狗鱼科鱼类所特有的副筛骨(proethmoid)的大部分,为一长条形骨片,其前端略宽,向后渐变窄,后端略尖(图 3.1,2)。鼻骨未保存。亦未见侧筛骨。

腭部 腭部骨骼在正型标本及 V 11690 上保存了一系列不甚完整的骨片,大部均为腹视(图 2.2)。锄骨(vomer)前缘宽,向后渐变窄变尖,腹面覆有大量扁而尖的齿。其后的副蝶骨(parasphenoid)甚长,后部较宽,腹面光滑,无齿,腹面中部具一纵向凹槽,向前变浅变宽。V 11690 副蝶骨左侧保存了长形的腭骨(palatine),轮廓虽不甚清晰,但能见腹面覆有许多倒伏的齿,均呈扁尖状(图 2.2);正型标本中亦保存了不完整的左侧腭骨,只保存了齿的根部及散落在围岩中的少量扁而尖的小齿(图 4.1,2)。外翼骨(ectopterygoid)在正型标本及 V 11690.11(与 V 11690.1 在同一石板上)中均保存尚好,中部弯曲,甚粗壮(图 4.1,2)。内翼骨(entopterygoid)亦部分保存,较单薄。在 V 11690.11 中舌颌骨(hyomandibular)前腹方保存了大部分后翼骨(metapterygoid),这一骨片较大(图 6.1,2)。在正型标本上可以看到方骨(quadrate),其前缘紧靠外翼骨前缘(图 4.1,2)。续骨没有保存。

颌部 颌部骨片在正型标本中保存了较好的左、右前上颌骨(图 4.1,2),是长形的小骨片,腹缘有扁而尖的小齿组成的齿带,骨片前半部之上为三角形薄片,后半部呈长条状。V 11690.12 上可以看到除前、后端缺失外其余部分保存较好的左侧上颌骨(图 5.2),V 11690 保存了左侧上颌骨的印痕,V 11690.9 保存了右侧上颌骨的后半段(图 5.3),腹缘均无齿。正型标本仅保存了上颌骨的破碎片断,其前端与腭骨相关节(图 4.2)。辅上颌骨没有保存。正型标本及 V 11690、V 11690.9、V 11690.12 均保存了部分下颌骨骼(图2.1,2;4.1,2;5.2,3), V 11690.9 保存了齿骨后半部、隅 - 关节骨(angulo-articular)及长条形的后关节骨(retroarticular),齿骨口缘有较大的扁尖齿,隅 - 关节骨及后关节骨后部表面布满明显的纵脊状纹饰,前者与方骨连接的关节窝保存甚佳(图 5.3)。V 11690.10 上可以看到齿骨后部及其口缘牙齿的印痕。V 11690 标本下颌的长度约为 110mm,约为头长的 5/7,可见口裂甚长。从齿骨口缘较大的齿槽和散落在周围的牙齿来看,齿骨上的牙齿较大,均为扁尖状,由于保存情况较差,无法确定齿骨是否载有犬齿状齿。正型标本保存了隅 - 关节骨的后部及后关节骨,与方骨的关节清晰可见(图 4.2)。



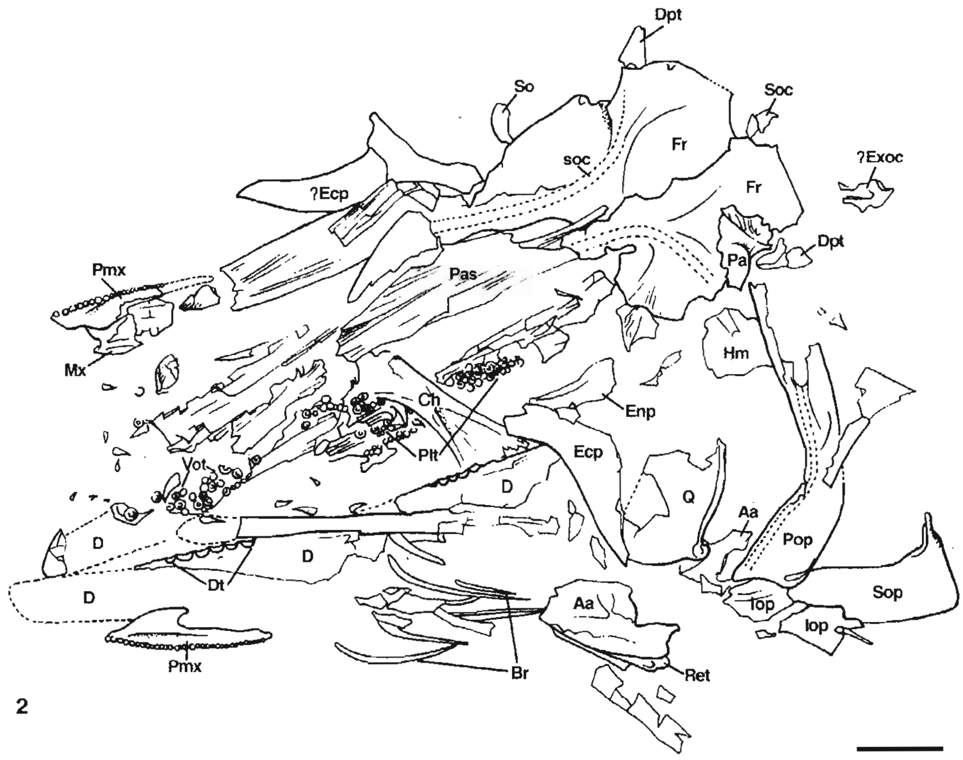


图4 龙口狗鱼,V 11690.2(正型标本):1,2,头部左侧视

Fig.4 *E*. *longkouensis*, holotype, 1,2, head in left view

Aa, angulo-articular(隅 - 关节骨);Br, branchiostegal rays (鳃条骨);? br. ar,? branchial arch(鳃弓);Ch, ceratohyal (角舌骨);D, dentary (齿骨);Dpt, dermopterotic (膜质翼耳骨);Dt, teeth on dentary (齿骨齿);Ecp, ectopterygoid (外翼骨);Enp, entopterygoid (内翼骨);? Exoc, ? exoccipital (? 外枕骨);Fr, frontal (额骨); Hm, hyomandibular(舌颌骨);Iop, interopercular (间鳃盖骨);Mx, Maxilla (上颌骨);Op, opercular (鳃盖骨); Pa, parietal (顶骨); Pas, parasphenoid (副蝶骨);Pl. palatine(腭骨);Plt, teeth on palatine (腭骨齿);Pmx, premaxilla (前上颌骨);Pop, preopercular (前鳃盖骨);Pre. Proethmoid (副筛骨);Q, quadrate (方骨); Ret, retroarticular (后关节骨); Scl, supracleithrum (上匙骨); So, supraorbital (上眶骨);soc, supraorbital sensory canal (眶上感觉管);Soc, supraoccipital (上枕骨); Sop, subopercular (下鳃盖骨);Vot, vomerine teeth (锄骨齿)

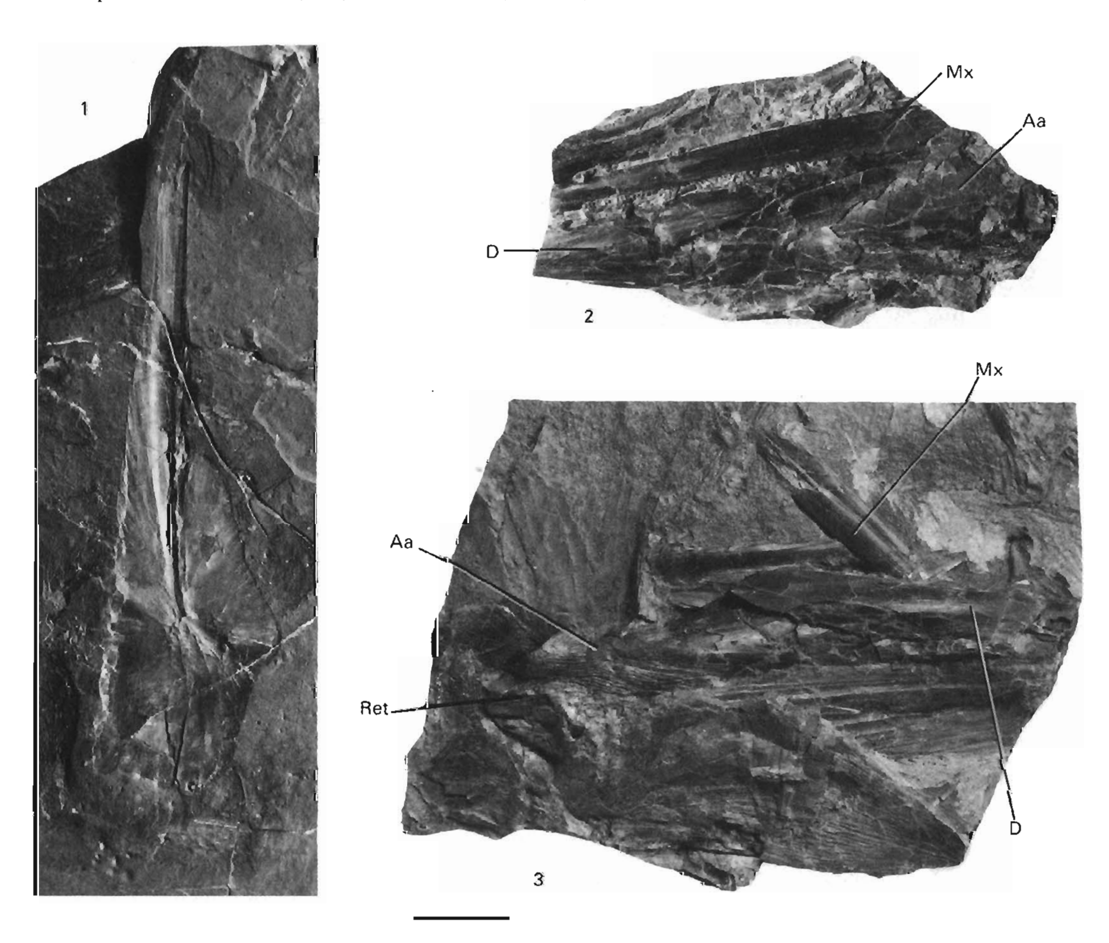


图5 龙口狗鱼,1. V 11690.5b,额骨,前端朝上;2. V 11690.12,颌部左侧视,前端朝左;3. V 11690.9,颌部右侧视,前端朝右,简字说明见图4

Fig.5 *E. longkouensis*, 1. V 11690,5b, left frontal, anterior facing up; 2. V 11690.12, part of jaw in left view, anterior facing left; 3. V 11690.9, part of jaw in right view, anterior facing right. For abbreviations see Fig.4

鳃盖系列 V 11690保存了左侧鳃盖骨的大部印痕及前缘部分骨片,大致呈长方形,腹缘未保存,前上角与舌颌骨相连的突起破碎,背缘保存不佳(图2.1,2)。在正型标本上

可以看到前鳃盖骨与现生狗鱼中相似,整个骨片较直,中部略弯并略收缩,上枝和下枝间夹角约为130°(图4.2),似较*Esox kronneri*的前鳃盖骨为弯而较*E. tiemani*的略直(与Grande, 1999,图2B及Wilson, 1984,图7比较),前鳃盖感觉管(preopercular sensory canal)由此骨前缘通过,包于骨片中。间鳃盖骨只保留了一些碎片,而下鳃盖骨则大部完整,虽然在此标本上前后倒转,且后部被可能属于间鳃盖的碎骨片掩盖,但仍能看到它的大致形状及清楚的前背突(图4.1,2)。在正型标本上虽可数出约10根纤细的鳃条骨(图4.1,2),但确切的总数不详。V 11690.1额骨前部右侧的细长骨可能是鳃弓的片断。

舌弓 舌颌骨在V 11690.11上比较完整,硕大粗壮,与脑颅相接的突起宽大。向前延伸的与鳃盖骨连接的突起破损。向下延伸的骨干直,亦可见与其前缘相接的后翼骨的一部分(图6.1,2)。舌骨中只保存了完整的角舌骨,呈凹透镜状(V 11690.6,图7.2),前端较后端窄。正型标本及V 11690.7上保存了不甚完整的角舌骨(图4.2)。

肩带 肩带骨骼中V 11690.1保存了较完整的右侧后颞骨(posttemporal,图3.1,2),与其他现生狗鱼中无异。V 11690基枕骨之后的一个较破碎的骨片及其印痕为右侧上匙骨(supracleithrum,图2.2),骨片表面接近顶端处见一小孔,通向沿骨片后缘下行的管,供侧线感觉管经此骨通向体侧。V 11690.3保存了相当完整的匙骨(cleithrum),与一般狗鱼中甚相似,其纵枝短,上端尖,而水平枝甚长。同一标本中匙骨前方腹侧有略位移了的较完整的乌喙骨(coracoid)和略破损的肩胛骨(scapula),并可见少量基鳍骨和胸鳍条(图7.1)。未见后匙骨(postcleithrum)。



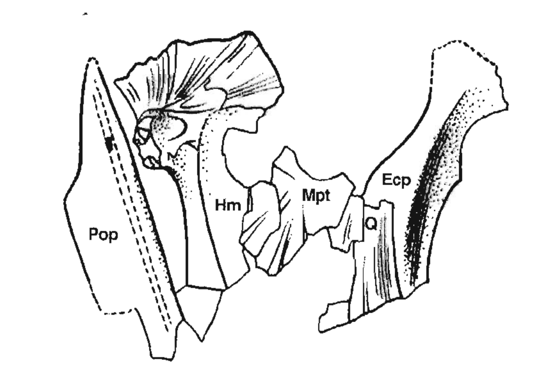


图6 龙口狗鱼,V 11690.11,1,2,舌颌骨、前鳃盖骨上部、后翼骨、外翼骨及部分方骨,鱼的前端朝右

Fig.6 *E. longkouensis*, 1, 2, hyomandibular (Hm), upper part of preopercular (Pop), metapterygoid (Mpt), ectopterygoid (Ecp), and a small portion of quadrate (Q), anterior facing right

脊椎 由于V 11690鱼体保存极差,脊柱扭曲、破碎,无法数出确切的脊椎数目,我们数出标本上保存的脊椎数,看不清楚的部位只能依邻近脊椎的长度来大致推算,所以,根据实际保存的和推测的脊椎相加的总数是很不可靠的。但我们仍将估计的数字(约59枚)记录在此,作为对龙口狗鱼可能具有的脊椎数目的大致参考。肋骨细弱,数目不详。无法看清肌间骨。在V 11690上保存了不完整的左侧胸鳍,能数出的鳍条数为13根,两侧腹鳍都保存不全,右

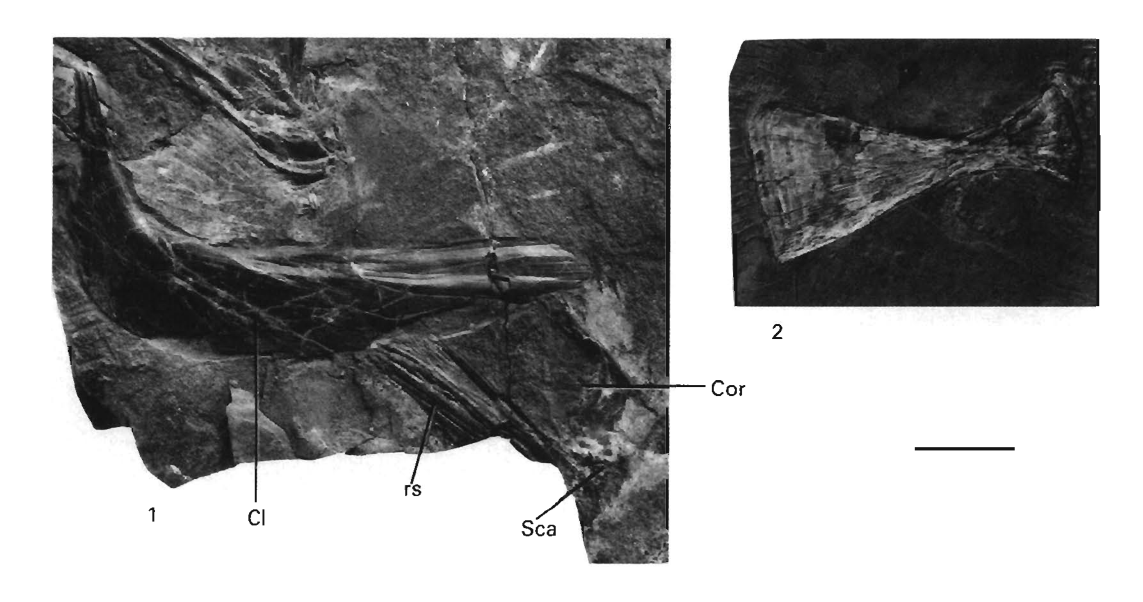


图7 龙口狗鱼,1. V 11690.3,肩带;2. V 11690.6,角舌骨,二图中鱼的前端均朝右

Fig.7 *E. longkouensis*, 1. V11690.3 shoulder girdle; 2. V 11690.6, ceratohyal. Anterior facing right in both figures. Cl, cleithrum(匙骨);Cor, coracoid(乌喙骨);rs, fin rays(鳍条),Sca, scapula(肩胛骨)

侧的较左侧的略完整,鳍条数约11根,长形的基鳍骨十分破碎。背鳍条数比较可靠,约有长鳍条18根及其前短鳍条5根,共23根。尾鳍未保存。尾骨骼保存很差,无法分辨其结构。

3 讨论

3.1 龙口狗鱼的系统位置

本文记述的产于山东龙口黄县洼里煤矿黄县组二段油页岩中的几个化石,虽然保存欠佳,但鉴定为狗鱼(*Esox*)应是毫无疑问的。它的身体狭长,背鳍位置靠后。额骨侧面有长形的、狗鱼所特有的副筛骨。额骨甚长。顶骨相对来说甚短,略呈横宽的长方形。口裂较长,齿骨、前上颌骨及腭部许多骨片均生有扁而尖的牙齿,而上颌骨口缘光滑。外翼骨甚粗壮。鳃盖骨略呈长方形。前鳃盖骨较直,中部略收缩,上、下枝夹角大(约为130°)。匙骨纵枝短而水平枝长大。这些都是狗鱼科或狗鱼属鱼类的特征(见 Wilson, 1984; Grande, 1999)。从保存较好的颅顶、腭部及颊部的情况以及几个保存较好的单个骨片来看,龙口标本与现生赖氏狗鱼的相应部分并无多大差别。

据以往研究,狗鱼属现生的5个种可分为两个亚属:*Esox* 亚属及 *Kenoza* 亚属(Nelson, 1972; Sytchevskaya, 1976; Grande, 1999)。*Esox* 亚属包括现代分布在北极圈周边地区的白斑狗鱼(*E. lucius*)、分布在中国东北部及西伯利亚邻近地区的赖氏狗鱼(*E. reicherti*)以及分布在北美东南部的 *E. masquinongy*。*Kenoza* 亚属则包括了狗鱼属其余的两个种:*E. niger* 和 *E. americanus*,它们的分布局限于北美东南部。目前已知最早的化石狗鱼仅发现于北美上白垩统地层中:加拿大阿尔伯塔省的 *Oldmanesox canadensis* 和美国怀俄明州的

Estesesox foxi(Wilson et al., 1992),虽均被确定为新属新种,但仅以破碎的或较完整的颌部骨片为代表。此前发现的古新世和始新世的狗鱼化石产地亦仅限于北美:加拿大阿尔伯塔省古新世的 *E. tiemani*(Wilson, 1984)和美国怀俄明州早始新世晚期的 *E. kronneri*(Grande, 1999),均被确定为狗鱼属的新种。这两个种的标本保存得相当完整,特别是前者,标本数量较多。后者只有一个标本,而且较小,全长仅 118mm,体长 97mm。虽然自渐新世起,狗鱼化石开始在欧洲、中亚和西伯利亚西部逐渐出现,但在渐新世以前的地层中,至今尚未在北美以外的地区发现过。龙口狗鱼是始新世(或古新世晚期)狗鱼属鱼类在北美以外地区(亚洲东部)的首次发现,虽然保存不够完整,但是确凿无疑的狗鱼。

根据 Wilson(1984)的观察,古新世的 *E. tiemani* 是当时了解得最清楚的化石种类,它的特征,特别是它的各个测量数据,与当时已知其他现生及化石狗鱼的特征比较,呈一种镶嵌(mosaic)分布的状态,因此应是一个新种。例如它的鳃盖骨形状和比例,以及附着在角舌骨和上舌骨(epihyal)上的鳃条骨数目,正好介于狗鱼亚目(Esocoidei)中另一个现生的荫鱼科(Umbridae, Günther, 1880)和狗鱼科之间,在狗鱼科中应属较原始的特征,而它的脊椎数目(59)在狗鱼中却与较进步的狗鱼亚属的脊椎数接近。龙口标本没有保存全部鳃条骨,也无法看到它们附着在舌骨上的情况。同时,它的鳃盖也保存得不甚完整,但仅根据保存的部分我们可以看到,这一骨片更加接近 *E. kronneri* 和现生种类中的情况,而和 *E. tiemani* 中的情况差别较大。根据 Grande(1999)的描述,绿河页岩 Fossil Butte Member 早始新世晚期的 *E. kronneri* 是另一个研究得较好的种类。由于保存完整,测量数据及种征的依据都比较可靠。但这些数据并非完全没有和其他种类中的数据重叠的地方,例如它的脊椎数目(47)虽然在狗鱼中是相当少的,但毕竟还有其他种类,如 *Kenoza* 亚属中 *E. americanus* 的两个亚种(*E. a. americanus* 及 *E. a. vermiculatus*)的有些个体的脊椎数目比它更少(分别为 44 ~ 51 和 42 ~ 49)。其他测量数据如尾椎、臀鳍条、头长与体长之比等等也有同样的情况(见 Grande, 1999, 274;表 1,2)。

龙口标本头长为体长之 0.33,与 *E. kronneri* 接近(0.34),与狗鱼亚属中出现在中国的两个种(*E. lucius* 和 *E. reicherti*)的某些个体中的情况(分别为 0.30 ~ 0.35 及 0.26 ~ 0.35)也较接近,而和 *E. tiemani* 中的比值(0.29)有别。它的额骨长度约为头长的 0.72,较 *E. kronneri* 略短(据 Grande,1999,后者中的这一数据为 0.75),但因测量数据不够准确,这样小的一点差别很难说明什么问题;其宽度为长度的 0.29,为 *E. kronneri* 额骨宽度(0.19)的 1.5 倍,应该算是比较大的差别,但后者的测量数据是否可能因标本的保存情况而有误差便不得而知了。龙口标本顶骨宽与长之比为 1.53,较 *E. knonneri* 的同一比值(1.88, Grande, 1999)要小。背鳍条为 V + 18 = 23 根,与 *Esox* 亚属中的三个种接近,而比其他现生及化石种中为多(见 Grande,1999,表 2;*E. kronneri* 中为 V + 14)。脊椎数约 59,与 *E. tiemani* 接近,而与其他种中不同(与 Grande, 1999, 274;表 1,2 比较)。鳃条骨数目可能大于 10 根,是狗鱼属中的一般情况。龙口标本的前鳃盖骨较直,其上、下枝夹角(130°)介于 *E. kronneri*(约 140°,据 Grande, 1999,图 2B)和 *E. tiemani*(略小于 130°,据 Wilson,1984,图 2)之间;不过,这种据图测量的办法并不准确,而且,就在我们作为对比用的三个标本中,前鳃盖骨上、下枝的夹角在两个标本上是 140°,而在第三个标本中却是 150°。看来,这一特征也很难作为可靠的依据。但根据以上情形,不同种类的狗鱼的一些性状在龙口狗鱼中也是呈镶嵌分布的。遗憾的是,龙口狗鱼保存较差,上述特征中有一些是估计

的,因此不够准确。但头长与体长之比、额骨及顶骨的形状和比例以及背鳍条数目应该是比较可靠的。根据这种情况,我们将龙口的标本定为一个新种,尽管这种做法有些勉强,还有待更多的标本来补足它的种征。至于龙口狗鱼与哪一个亚属更接近,我们目前尚无充分的根据来进行讨论。但无论如何,狗鱼在东亚始新世地层中的发现具有重要的意义是毋容置疑的。

3.2 龙口狗鱼的生态环境

龙口狗鱼产出的地点位于北纬37°7′,远较现生狗鱼在亚洲分布的地区(43°和46°以北)靠南。比北美怀俄明州早始新世晚期 *E. kronneri* 的产地亦略偏南,大约与科罗拉多州早始新世 Coalmont 组产狗鱼未定种(Wilson, 1981)的地点的纬度接近。由于 *Kenoza* 亚属的两个现生种分布在北美东南部,Grande(1999)认为 *E. kronneri* 的产地偏南可能表明其生态环境处于亚热带或甚至热带,与现生 *Kenoza* 亚属鱼类分布情况相似,并将此作为 *E. kronneri* 可能归入 *Kenoza* 亚属的根据之一。据我们所知,始新世全球气候偏暖,且高、低纬度间温差较小(Janis, 1993; Chang et al., 2001),因此,早期狗鱼或都能适应较现代更温暖的气候。Nelson(1972)主张 *Kenoza* 亚属较 *Esox* 亚属原始,但由于龙口狗鱼保存不够完整,且亦具有与 *Esox* 亚属中的某些种类相同的特征,我们尚不能仅根据其适应较温暖的气候而推测它是否与 *Kenoza* 亚属关系更近。

3.3 再论始新世鱼类的跨太平洋分布

我们在以往的工作中曾多次提到始新世鱼类的跨太平洋分布(张弥曼、周家健,1978; Chang and Zhou, 1993; Chang and Chen, 2000; Grande, 1994)。虽然狗鱼自中新世以来已广布在北半球极圈周围,但前文中已指出,中生代晚期狗鱼科鱼类只发现在北美,早始新世(或古新世晚期)则在北美和东亚都有分布。而欧洲和中亚至今未见始新世及其以前狗鱼科鱼类的踪迹,那里同时代地层中发现的化石是狗鱼科鱼类的近亲;狗鱼亚目的另一个现生科荫鱼科和一个化石科 Palaeoesocidae 科(Berg, 1936; Sychevskaya, 1976)的成员。因此,狗鱼属鱼类在中国的发现为始新世鱼类的跨太平洋分布模式又增添了一个北美和东亚共有的种类,进一步证明了当时东亚和北美鱼类区系的相似和接近。这种分布模式以及形成这种模式的原因是目前研究太平洋海盆及环太平洋地区新生代地质历史的关键问题之一,近来很受世界有关研究者的重视。

致谢 承蒙山东龙口市草泊煤矿徐爱厚工程师提供 V 11690 标本,哈尔滨技术物理研究所肖度元先生费心收集现生狗鱼标本,张杰摄制照片,黄金玲绘制插图,特此致谢。

FIRST DISCOVERY OF FOSSIL PIKE (*ESOX*, PISCES, TELEOSTEI) FROM CHINA

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Key words Longkou, Shandong, Eocene, pike, first discovery in China

Summary

Pikes (Esocidae) are freshwater fishes now dwelling in northern hemisphere, most of them in cold waters south to the polar circle. The family contains only one genus (*Esox*) with five Recent species. Among them two appear in China, one (*Esox reicherti*) in the northeastern part of China, in the Amur, Sungaria and Wusuli rivers' valley; the other (*E. lucius*) in the Ertys River in Xinjiang, northwestern China (Meng et al., 1995). The finds of the Late Cretaceous, Paleocene and Eocene pikes were so far restricted to North America although their distribution became much wider starting from the Oligocene (Cavender et al. 1970; Sychevskaya, 1974, 1976; Gaudant, 1978, 1987; Wilson, 1980, 1981, 1984; Wilson et al., 1992; Grande, 1999). Thus, the fossil pike described in this paper is the first discovery of its kind from the early Eocene (or late Paleocene) outside of North America.

The specimens of pikes described in this paper were collected from the Member 2 of the Huangxian Formation in Wali Coal Mine, Huangxian County, Longkou, Shandong Province (Fig.1). No remains of vertebrates other than fish were found from the Huangxian Formation. Its correlation with the Wutu Formation in the nearby Wutu Basin was based on pollen (*Paraalnipollenites-Betulaepollenites plicoides-Polypodiaceaesporites* assemblage) and ostracods (e. g. *Eucypris wutuensis*) found in both formations. The age of the Wutu Formation has been considered as early Eocene by the findings of *Homogalax wutuensis* and *Heptodon niushanensis* (Chow and Li, 1965). A big variety of fossil mammals belonging to several big groups were discovered recently from the Wutu Formation. Based on the study of the phylogeny of these groups combined with paleobiogeographic, paleoclimatic and biostratigraphic studies of North America and East Asia some researchers suggest the possibility of the age of the Wutu Formation as late Paleocene (Beard and Wang, 1995; Tong and Dawson, 1995; Beard, 1998; Beard and Dawson, 1999). Associated with the pike were disarticulated bones of amiids which are under description by the present authors.

Teleostei
Order Esociformes
Suborder Esocoidei Berg, 1936
Family Esocidae Cuvier, 1817
Genus *Esox* Linnaeus, 1758
***Esox longkouensis* sp. nov.**
(Figs.2 — 7)

Diagnosis A species of *Esox* with the following combination of characters: head length to standard length ratio 0.33, width-to-length ratio of frontal 0.29, width-to-length ratio of parietal 1.53, shape of opercular close to *E. kronneri* and the Recent species than to *E. tiemani*, number of dorsal fin rays V + 18 = 23, preopercular comparatively straight, angle between its upper and lower branches 130°, thus with mosaic distribution of characters occurred in some other fossil and Re-

cent species.

Holotype A skull in left view with most of its bones preserved, V 11690.2.

Paratype A severely twisted fish body without caudal fin, V 11690, and a skull roof, V 11690.1.

Other materials Detached bones of the head and shoulder girdle, V 11690. 3-7,9-12.

Locality and age Wali coal mine, Huangxian county, Longkou, Shandong Province, China; Member 2 of Huangxian Formation, early Eocene (or late Paleocene).

Etymology Longkou-, the name of the city nearest to the fish locality.

Description, comparison and discussion As far as we can make out from the specimen V 11690 the fish is a comparatively large one with the standard length about 471mm. It has an elongated body. The dorsal fin is posteriorly situated (Fig.2,1). The frontal is long (Fig. 5.1), with a width-to-length ratio as 0.29. The parietal is short (Fig. 3.1,2). Antero-lateral to the frontals there is a long, paired proethmoid (Fig. 3.1, 2), characteristic for pikes. The mouth gape is large, with the length of the mandible approximately 5/7 of the head length (Fig. 2.1,2). The dentary, premaxilla, bones of the palate are all covered with compressed, pointed teeth (Fig. 2.2; 4.1,2) but the maxilla has a smooth mouth margin with no teeth (Fig. 5.2,3). The ectopterygoid is robust, bent in the middle (Fig. 4.1,2). The opercular is more or less rectangular (Fig. 2.2) while the preopercular is comparatively straight, somewhat constricted in the middle, with the angle between upper and lower branches around 130° (Fig. 4.1,2). The large cleithrum is with a short vertical and long horizontal branches (Fig. 7.1). Based on all the above-mentioned characters of the newly found fish from Longkou it is doubtless that it can be referred to the genus *Esox*. The skull roof, the conditions of the palate and cheek, and the few well-preserved detached bones of the Longkou specimens are not much different from their equivalents in the Recent species *E. reicherti*.

The length of head to standard length ratio in V 11690 is approximately 0.33, close to that in *E. kronneri* (0.34) and is within the range of the variation of the two species of the subgenus *Esox* occurring in Asia, i. e. *E. lucius* and *E. reicherti* (0.30 ~ 0.35 and 0.26 ~ 0.35 respectively). The ratio is higher than that in the Canadian Paleocene species *E. tiemani* (0.29). The frontal length to head length ratio in the same specimen is 0.72, somewhat smaller than that in *E. kronneri* (0.75, Grande, 1999). Since the measurement might not be precise it is hard to say what can such tiny difference imply. The width to length ratio of the bone (0.29), nevertheless, is 1.5 times of that of *E. kronneri* (0.19). This can be counted as a more robust character. The width to length ratio of the parietal in the Longkou form is 1.53, smaller than that in *E. kronneri* (1.88, Grande, 1999). The number of its dorsal fin rays is V + 18 = 23, closer to the three Recent species of the subgenus *Esox*, but higher than that in other Recent and fossil species (see Table 2 in Grande, 1999, V + 14 in *E. kronneri*). Its vertebrae number is approximately 59, similar to that in *E. tiemani* but different from other species (see Tables 1 and 2 from Grande, 1999). Based on what we can gather from the specimens at our disposal we can see, as Wilson stated about *E. tiemani*, characters occur in some species of *Esox* also have a mosaic distribution in the Longkou form. Among the above characters although some are not very accurate, the ratio of the head length to standard length, the shape and proportions of the frontal and parietal, and the number of the dorsal fin rays are more reliable. Judging from all this we decide to designate the Longkou form as a new species of *Esox*: *E. longkouensis* though the characters keeping up it as a new species are, in fact, comparatively weak. We expect more new finds to provide more support. As for to which subgenus should *Esox longkouensis* belong we do not yet have adequate grounds to form an opinion. Nevertheless, the discovery of *Esox* in the Eocene of East Asia is of great consequence.

The locality of *Esox longkouensis* is at 37°7′ northern latitude, obviously south to the distribution area of their Recent allies. It is also a bit more south than the locality of the early Eocene *E. kronneri* from Wyoming and close in latitude to the locality of *Esox* sp. from the early Eocene Coalmont Formation of Colorado reported by Wilson (1981). Since the two Recent species of the

subgenus *Kenoza* are distributed in the southeastern part of North America Grande (1999) took the southern occurrence of *E. kronneri* as the indication of its environment as subtropical or even tropical and viewed it as a piece of evidence to refer the species to the subgenus *Kenoza*. As far as we know, during the Eocene the global climate was on the whole warmer than now and the temperature gradient in latitude was low (Janis, 1993; Chang et al., 2001). It is conceivable that the Eocene esocids must have adapted to warmer climate than now. Nelson (1972) proposed that *Kenoza* is more primitive than *Esox*. Yet the specimens of *E. longkouensis* are not well preserved and it bears more characters of the subgenus *Esox* than *Kenoza*. For that reason, we do not think we can suggest its closer relatiohship with *Kenoza* just based on its adaptation to warmer climate.

In our former studies we frequently mentioned about the similarities between the Eocene fish fauna from China and that from North America (Chang and Zhou, 1978, 1993; Zhang et al. 1985; Chang and Chen, 2000). Although starting from the Miocene *Esox* has already gained a circum-Arctic distribution the Late Mesozoic esocids are just restricted to North America. With the discovery of *E. longkouensis* the early Eocene (or late Paleocene) esocid distribution now expanded from North America to East Asia. So far there are no traces of early esocids discovered in Europe and Middle East. In the early Tertiary deposits of those areas only close relatives of esocids were found. They are members of the Recent family Umbriidae and the fossil family Paleoesocidae of the Esocoidea (Berg, 1936; Sychevskaya, 1976). Therefore, the discovery of *Esox* in China added one more genus shared by the two sides of the Pacific during the early Tertiary. It renders further support to the close relationship between the Eocene Asian and North American fish faunas. This distributional pattern and the geological events causing the formation of the pattern are among the key problems in the current research of the history (origin) of the Pacific Basin and the Cenozoic geology of the circum-Pacific area and thus are appealing to many researchers.

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